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ARISTOGENESIS, THE CREATIVE PRINCIPLE IN THE ORIGIN OF SPECIES[1]

By Professor HENRY FAIRFIELD OSBORN

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As the title of his epoch-making work Darwin chose "The Origin of Species" (1859) because, as conceived by Linnaeus (1735), "species" was the ultimate unit of creation in the animal and plant world. *Nullae speciae novae* was the battle cry of the conservatives of pre-Darwin days, but what Darwin devoted his life to was the origin not of species but of adaptations, of which species are simply the by-products.

Mechanical adaptation was the oriflamme from Empedocles (495–435 B. C.), the father of the evolution idea, through Anaxagoras, Aeschylus, Aristotle and Plato, in forming what may be called the proto-Darwinian "chance hypothesis" as well as the proto-Lamarckian "inheritance of acquired adaption hypothesis." The progressive improvement or retrogressive degeneration of human and animal mechanisms were the guideposts to the use and disuse inheritance speculations from the naturalists of Greece and Rome to Erasmus Darwin and Lamarck, the formulator of the "Lamarckian hypothesis."

Osborn, too, for the past forty-three years a hunter of fossil titanotheres, of fossil mastodonts and elephants, concerned with the origin of the masterful horns of the titanotheres; in the elephants of the superb tusks, of the marvelous proboscis, of the supreme mechanical adaptation of the great grinders which grind uninterruptedly for over a century, loves to feel that in part at least he has answered Aristotle's question: "What then, hinders but that the parts in nature may also thus arise? For instance, that the

[1] Abstract of eleventh William T. Sedgwick Memorial Lecture, delivered at the Massachusetts Institute of Technology, Cambridge, Mass., at the meeting of the American Association for the Advancement of Science and the American Society of Naturalists, December 29, 1933.

teeth should arise from necessity, the front teeth sharp and adapted to divide the food, the grinders broad and adapted to breaking the food into pieces."

If any intellectual creed—for scientists have their creeds as well as theologians—may be slain by forty-three years of broad and intensive observation on the actual modes of the origin of species, it is the Empedoclean creed of "chance." Whatever may be true of the origin of the biophysical or biochemical adaptations of life, it is now positively demonstrated that nature never gambles or takes a "chance" mechanical adaptation in her origin of species.

In the recent language of the great physicist Bohr, organic mechanism is clearly distinguished from inorganic mechanism:

> On this view, the existence of life must be considered as an elementary fact that can not be explained, but must be taken as a starting point in biology, in a similar way as the quantum of action, which appears as an irrational element from the point of view of classical mechanical physics, taken together with the existence of the elementary particles, forms the foundation of atomic physics.

To borrow Bohr's metaphor, life is a "quantum" of adaptive action, reaction and interaction. Before life appeared on our planet not a single combination of energy and matter was capable of resisting shock, of repairing waste, of combatting disintegration, of coordinating reaction or resistance.

Is it not a significant fact that long prior to modern discoveries of liaison, correlating, interacting and coordinating processes in biophysics and biochemistry, naturalists like Hyatt, Cope and Osborn were applying mechanical and physical terminology to paleontological processes. Modern mechanics afford us, says Planck, the newest concepts of force, of acceleration, of retardation or of inertia, and of mass: "The main object of mechanics is to find the motion which results from a prescribed cause."

A synthesis of outstanding biochemical generalizations may be made from Hopkins' recent address on "Some Chemical Aspects of Life," as follows: Life's advent is the most significant event in the history of the universe; life obeys the second law of thermodynamics; in its energy flow it provides potential activities; of equal importance is organization; among its various means of trapping and transforming radiant energy are chlorophyll, autotrophic bacteria and purple bacteria.

Centering around biomechanical adaptations in the vertebrate class, including fishes, amphibians, reptiles, birds and mammals, are the definitions of species, genera, families and orders. Through intensive paleontologic research we have now perfectly clear concepts of what the formerly dry systematic terms "species," "genera," etc., mean. Paleontology revivifies these terms with principles of potentiality, of acceleration, of the coordinated significance of every process.

From the dawning comparative anatomy of Aristotle to the specific definitions of Linnæus, five locomotor types of quadrupeds have been recognized. Now for the first time, through very intensive alloiometric methods in the titanotheres, elephants and horses, we know how these highly divergent locomotor types evolve.

During the past forty-three years an opportunity quite without precedent in the whole history of biology has enabled us to replace more or less wild and random speculation and hypotheses of the past by observations, inductions, generalizations and principles soundly established in the titanotheres, verified, confirmed and extended in the proboscideans. For the first time in the 2,380 years of evolutionary speculation principles of phylogeny or animal descent become truly scientific when we can measure and number them in the sense of Francis Galton.

With the constant aid of William King Gregory we have applied the principles of measurement under the Greek term alloiometry, signifying the measurement of the always differential changes of proportion, with most significant new results on the widely contrasting heads, limbs, feet and teeth of the titanotheres and of the proboscideans. Alloiometrons may now be clearly defined, as follows:

> Alloiometrons are not governed or predetermined by germinal potentiality in certain lines of racial, specific, generic, family and ordinal descent. On the contrary, within species and even within races, for example the modern species of man *Homo sapiens*, diverse alloiometrons or more or less profound changes of proportion, are independently arising. Alloiometrons are relatively rapid in development, or temporal.

The limbs of both the giant titanotheres and elephants are in the slow-moving, weight-carrying graviportal type of quadruped with short feet. The alloiometrons of the titanothere limb segments are not so very dissimilar to those of the elephants, but both titanotheres and elephants present the widest possible contrasts to the alloiometrons of the cursorial equines, deer and antelope. *Equus* shares with all other swift-footed vertebrates the short thigh and arm bones and long lower limbs, while *Elephas* shares with all heavy slow-moving vertebrates the long thigh bone and the short lower limb. The elephantine alloiometrons (femur, 48.6 per cent.; tibia, 34.3 per cent.; pes, 17.1 per cent.) are similar to those of the giant dinosaur *Camarasaurus* Osborn, namely: femur, 48.6 per cent.; tibia, 33.7 per cent.; pes, 17.7 per cent. Close parallels with the equine alloiometrons

are those of the swift-footed deer, antelope and gazelle.

The older testimony of comparative anatomy and embryology is enormously amplified by the testimony of paleontology, which is especially complete, on the ascending scale, in the speed ratios of the equines, *Eohippus* to *Equus,* over a period of thirty-five million years. The desert kiang reaches a maximum speed of thirty-five miles an hour; a few individuals attain forty miles an hour. As shown in the Gobi Desert observations of Andrews, the higher speed ratios are attained in the timid desert gazelle rather than in the desert kiang. We know the exact length ratios of the upper, middle and lower limb segments which correspond to these speeds. The desert gazelle (*Gazella subgutterosa*) is a light-bodied, slender-legged animal, reaching a maximum speed of sixty miles an hour for a short dash—perhaps a furlong; it can maintain its normal running speed of about forty miles an hour.

The Origin of Adaptations by Aristogenesis

We now pass over the boundary of quantitative evolution expressed in alloiometrons into an entirely new and separate domain of research and generalization. Before the now venerable Society of Naturalists forty-three years ago the discovery of aristogenes was adumbrated in the concluding sentence of Osborn's paper, entitled "Are Acquired Variations Inherited?": "Disprove Lamarck's principle and we must assume that there is some third factor in Evolution of which we are now ignorant." This previously unknown factor proves to be aristogenesis; it was first known under the term "definite variation," (1890) then in 1908 as "rectigradation."

As contrasted with the origin of adaptations through alloiometrons, aristogenesis is a creative process from the geneplasm of entirely new germinal biomechanisms; the process is continuous, gradual, direct, definite in the direction of future adaptation. In contrast to alloiometrons which appear to be immediate and more or less temporal adaptive reactions to new habits, aristogenes are secular, appearing very slowly in the course of long periods of geologic time. Lines of ordinal, family, generic and specific descent may be distinguished by the potentiality of certain new geneplasmic aristogenes.

Two of the principles controlling aristogenes were first demonstrated in the origin of the bony horns of titanotheres, namely, that while potentiality and predisposition and predetermination give definite origins of the horn rudiments, these rudiments do not appear simultaneously in diverse lines of phylogenetic descent but in intervals of time widely separated geologically, perhaps by thousands or hundred thousands of years.

In the whole field of comparative anatomy and zoology no wider contrast could be afforded than the adaptive evolution and radiation of the titanotheres intensively studied in my Titanothere Monograph for the United States Geological Survey, and the adaptive evolution and radiation of the Proboscidea, now in preparation for the Memoirs of the American Museum of Natural History.

If the increase in living species of mammals is twenty-fold the increase in fossil species of titanotheres and proboscideans is one hundred fold. Of still more significance as regards the origin of adaptations is our knowledge of no less than forty-five lines of generic proboscidean ascent, in which the coordinate play of aristogenic and alloiometric origins can be followed in closely continuous phylogenetic order. The breaks between the surviving terminal twigs of the giant branching trees of proboscidean ascent disappear, and the first grand result is the replacement of all hypotheses of discontinuity or of breaks between species. Darwin's species stood apart like isolated mountain peaks, whereas to-day owing to our discoveries living species and subspecies are often comparable to mountain chains composed of lesser peaks completely connected by ridges known as intergradations. It is not the number of species and subspecies which is significant, but the facts as to habit and habitat which are recorded with them. Similarly, it is not the number of fossil species now known as compared with those of Darwin's time, but the linkage of families, genera, species, subspecies, and even of "ascending" and "descending mutations" reaching back over hundreds of thousands, if not millions, of years.

While the Proboscidea as a whole are under the broad principle I of adaptive radiation, the several organs evolve separately under principle II of particulate adaptive radiation. This is what actually happens in the forty-five separate lines of descent; we now know exactly how it happens, how adaptations and species originate; we do not know why it happens; before speculating as to the why and as to the nature of the inconceivably numerous chemico-physical modes of coordination let us concentrate on the three outstanding biomechanical centers, namely, the tusks, the proboscis and the grinding teeth.

Most extraordinary, however, is the shoveling function which evolved independently in four entirely distinct lines of descent, two outstanding examples of which are the Amebelodonts or "shovel-tuskers" of North America, all alike descended from the primitive shovel-tusker *Phiomia,* described by Andrews from the Oligocene Lake Moeris of Egypt; also the Platybelodonts or "flat-tuskers" independently discovered by Borissiak, Granger and R. C. Andrews in the Desert of the Gobi. The three known species of

Platybelodon exhibit a perfected pair of broadened chisels, reinforced within by dentinal tubules, kept sharp by polishing the lower surface on smooth rocks; this pair of lower incisors combines to form a shovel twelve inches broad, in form exactly like a coal shovel.

It has been assumed by all zoologists that all proboscideans evolved a proboscis and that ancestral proboscideans would show step by step the evolution of this remarkable organ. Accordingly, in all current literature and popular restorations the proboscis is shown in its variable stages; in our restorations three entirely distinct modes of naso-labial adaptation are displayed. After the most intensive research it appears that there are three widely distinct naso-labial adaptations; namely, (a) the broad hippopotamoid upper and lower lips of the Moeritheres; (b) the flat extended upper lip of the flat-tuskers (*Platybelodon*) and of the shovel-tuskers (*Amebelodon*); (c) the typical elephantine proboscis progressively extended until it reaches the ground and is capable of a great variety of functions.

In the aristogenesis of the twenty-six kinds of mastodonts it is the adaptations of the superior and inferior tusks combined with the manifold adaptations of the grinding teeth which give us two outstanding results; first, from the biomechanical standpoint, tusk and grinder adaptations absolutely confirm the principle of particulate adaptive radiation; second, these adaptations of the grinders and of the tusks combined afford a reliable means of determining both the habitat and the nature of the food supply which underlies the principle of adaptive radiation of these animals as a whole.

Despite these ingenious biomechanisms of all the 27 different kinds of dental adaptation, the Moeritheres, Deinotheres and Mastodonts signally failed during the progressive Eocene to Pliocene desiccation. In the northern hemisphere all adaptations failed, excepting three. Falconer's *Anancus* of East Anglia and Barbour's *Tetralophodon* of Nebraska alone survived into the Lower Pleistocene, while our classic mastodont, *Mastodon americanus*, alone survived into the dense humid forests of middle and eastern North America.

In the surviving elephantoid division the low transverse ridge-crest of the mastodont is perfected in the Upper Pliocene of the African ancestral elephants (*Archidiskodon*). The contrasts in the total length of the enamel foldings of the gigantic *Archidiskodon* (8,000 mm), of the gigantic *Parelephas* (10,000 mm), of the relatively small *Mammonteus* (6,000 mm) are coordinated with the relative intensities of their struggle for existence.

The proboscideans rank next to man in biological importance and far surpass the mechanically inferior man in demonstration of all the main principles of biomechanical aristogenesis and alloiometry. It is difficult to circumscribe aristogenesis and alloiometry within their respective originating and modifying spheres of action, but there are certain lines of proboscidean descent in which aristogenesis, for a long period of time, is the sole and dominating principle. In a definitely known period of geologic time an outstanding example of aristogenic origin from the geneplasm is witnessed in the Siwalik Hills of northern India during the flood-plain deposition. We witness here the aristogenic origin from the geneplasm in a definitely known period of geologic time, Oligocene to Miocene, of 24 new biomechanical units. Each of these aristogenes rises from the creative potentiality of the geneplasm, first as an inconspicuous rudiment, finally as a functional and useful cone or enamel folding.

The next principle of great significance in biomechanical evolution is that these new aristogenic primary cones arise only in the genera which are more or less closely affiliated by descent to the ancestral *Phiomia* of the Upper Oligocene of Egypt collected by Granger on the American Museum Expedition of 1907.

The rapidity of evolution of the aristogenic elements in the grinding teeth is now known to be entirely independent of the intensity of the selection principle of Darwin. During the relatively brief Plio-Pleistocene million and a half year period all the elephants were protected by the superb development of their incisive tusks; these tusks, together with the greatly superior mechanism of the grinding teeth, enabled the elephants to completely supersede or drive out the mastodont stocks and to replace the mastodonts in all parts of the world except Australia from which they were barred by impassable oceanic barriers, and South America, in which only a single species (*Parelephas cayennensis*) penetrated as far as French Guiana. It is also known that no species of elephant occupied the same geographic range as another species at any given period of geologic time; thus there was no competition between species. So far as we can judge, the elephants were the most dominant, resourceful, well-defended quadrupeds known at any time in the earth's history prior to the arrival of man. The independence of selection in aristogenic evolution is shown by the amazing rapidity with which the grinding teeth evolved, this evolution far outstripping that of the grinders of any of the contemporaneous rapidly breeding mammals. Whereas it is often very difficult to distinguish a swift-breeding Lower Pleistocene rodent from a modern rodent, the gap between the grinding teeth of the slow-breeding elephants in the same period of time is enormous.

Among Osborn's theoretic inductions is the follow-

ing, that we are witnessing potentiality rather than predetermination. One definition of the term potential, *i.e.*, "Latent, undeveloped, but capable of developing and becoming effective; existing in the germ . . . ," while a purely physical term, appears to apply to the latency of the aristogenes both in the grinding teeth of the Proboscidea and in the horns of the titanotheres. The presence of this genedynamy or latent power in the germ, is attested by the entire history of the grinding teeth of the mammals extending back to the single coned pro-mammals of the Triassic time.

CONCLUSION

An interesting coincidence in the history of the evolution theory is that while William Bateson was working in Cambridge after his graduation (1882) from St. John's, under Weldon's direction he soon turned to the study of variation chiefly on the materials afforded in the Cambridge museums, and in the introductory pages to his well-known volume gave his preliminary conclusions: I. The forms of living things are various and, on the whole, are Discontinuous or Specific. II. The Specific forms, on the whole, fit the places they have to live in. How have these Discontinuous forms been brought into existence, and how is it they are thus adapted? This is the question the naturalist is to answer.

At the same time Osborn, studying in Cambridge (1879–1880) and Princeton (1881–1890), was also interested in the problem of variation, and in opening a discussion upon the Lamarckian principle before the American Society of Naturalists reached conclusions as to definite lines of blastogenic variation, as follows: "The conclusions we reach in this discussion must finally turn upon the existence of definite lines of blastogenic variation." Thus Osborn and Bateson laid out for themselves a program for future research based in Bateson's case on the concept of discontinuity between species, and in Osborn's case on the concept of the existence of definite lines of germinal variation still to be discovered.

The results of Bateson's research left him in a hopeless and agnostic mood. Osborn on the other hand is full of confidence.

Our knowledge of the chemical messengers which not only sustain the structural harmonies of the entire organism, but which hasten forward some processes and retard others, has advanced by leaps and bounds. We are still on the threshold of the biophysical messenger system, but the one fact that certain mammals are sensitive to slight changes in the barometric pressure of the atmosphere which heralds a coming storm is an indication of what we may anticipate in the physical sphere of action. The hard-won discoveries in aristogenesis which form the chief subject of the present address are entirely the outcome of the spirit of the "interpretation" of nature rather than the "anticipation" of nature, in the language of Bacon, the founder of inductive biology.

Nature is full of surprises; Nature seldom works according to the anticipations of man, even such semi-inductive anticipations as those of Charles Darwin and of Herbert Spencer. If, as we contend, the principle of Aristogenesis is firmly established by irrefutable paleontological evidence we are now in a new vantage point to attack the problem of the causes of biomechanical adaptations which have interested the mind and excited the imagination of man since the time of Empedocles. Let us summarize our present position for the direction of further research and experiment.

In biomechanical evolution there are two distinct processes. The one long known consists in the alloiometric modification of existing adaptations as in changes of proportion and of function. The other, discovered in course of researches on the phylogeny of the horses, titanotheres and proboscideans, consists in the gradual geneplasmic origin of new and distinct adaptations; it is to the latter originative and creative process that the term Aristogenesis is applied. Both processes become part of the hereditary equipment of the organism.

THE MECHANISM OF THE POLYMERIZATION AND DEPOLYMERIZATION OF OLEFINS[1]

By Professor FRANK C. WHITMORE

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ALTHOUGH the polymerization of olefins is nearly as old as organic chemistry and in spite of the increasing industrial importance of this process, especially in connection with cracked gasoline, the theories which have been propounded to explain it have not been adequate. In most cases they have assumed types of changes which are entirely different from ordinary organic reactions. The theory presented in the present address is different from the preceding

[1] Abstract of an address by the retiring vice-president and chairman of Section C—Chemistry, American Association for the Advancement of Science, Boston, December 29, 1933.

theories in that it assumes only successive additions of positive hydrogen ions and positive organic groups, corresponding to hydrogen ions, to molecules of olefins.

The suggestion for the present theory of polymerization came from some experiments in our rearrangement studies. The dehydration of a nonyl alcohol which was expected to give a nonene with the migration of a tertiary butyl group gave instead a pentene (trimethylethylene) and a butene (isobutylene). It thus became evident that the tertiary butyl group, instead of wandering with its electron pair during the rearrangement, had been deprived of the electron pair and left as a "positive" tertiary butyl group which immediately lost a hydrogen ion and became isobutylene. The formation of a pentene and a butene instead of the expected nonene was immediately recognized as a peculiar case of depolymerization. The suggestion became obvious that if this depolymerization consisted in the removal of a positive tertiary butyl group, then polymerization might consist in the addition of such a group to an olefin. This conception agrees with the experimental facts as recently determined in the case of the diisobutylenes and the triisobutylenes in this laboratory.

As will be recalled, the polymerization of olefins takes place most readily in the presence of acid catalysts. A great variety of substances which will give hydrogen ions will cause the polymerization of olefins. As is also well known, there is a great difference in the ease with which various olefins polymerize. Thus ethylene and propylene polymerize with considerable difficulty. The normal butenes polymerize somewhat more readily. Isobutylene polymerizes with extreme ease. The order of ease of polymerization of these substances is the same as the order of ease of addition of substances like hydrogen bromide. It has long been known that the first step in the reaction of an olefin consists in the addition of a positive group to one end of the double bond. This is believed to be due to the addition of the positive group to the extra electron pair of the double bond. After a positive group has added to the double bond, the other carbon is left with only six electrons and is, consequently, positive. This new positive fragment can add to another olefin in the same way to form a still larger positive fragment. Any one of these positive fragments can become stable by the loss of a positive hydrogen ion, thus leaving a double bond with the formation of an olefin molecule.

The condition existing at each step in the polymerization may be summarized by the following equation:

$$:\underset{\cdot\cdot}{C}::\underset{\cdot\cdot}{C}: + H^+ \rightleftarrows :\underset{\cdot\cdot}{C}:\overset{H}{\underset{\cdot\cdot}{C}}:$$

In the first step the double bond is that of isobutylene, which unites with a hydrogen ion to give a positive tertiary butyl radical. This positive tertiary butyl radical can add to a molecule of isobutylene to give a still larger positive fragment. This can either lose a hydrogen ion to give a diisobutylene or can add to another molecule of isobutylene to give a positive fragment related to the triisobutylenes. The diisobutylene and the triisobutylene, in turn, can react with positive tertiary butyl groups or even with larger positive groups in the reaction mixture. The regeneration of hydrogen ions from the positive fragments makes the polymerization truly catalytic.

This theory can be applied in detail to the polymerization of isobutylene. The first step is the addition of a hydrogen ion to the methylene group of the isobutylene to give a tertiary butyl group, the central carbon of which has only six electrons and is therefore positive. This process is reversible. The tertiary butyl group can then add to the methylene group of another isobutylene molecule to form a larger positive fragment. This process may be illustrated as follows:

$$\begin{array}{l} \quad H \quad\quad Me \\ Me:C::\ddot{C} + \ddot{C}:Me \longrightarrow \end{array} \begin{array}{l} \quad\quad\quad H \quad Me \\ Me:C:\ddot{C}:\ddot{C}:Me \\ \quad\quad\quad Me \quad H \quad Me \end{array}$$

The instability caused by the carbon with only six electrons may be overcome by the loss of a hydrogen ion, either from one of the adjacent methyl groups or from the adjacent methylene group. The loss of the hydrogen ion leaves a double bond in the corresponding position. The two olefins thus obtainable would be 2, 4, 4-trimethylpentene-1 and 2, 4, 4-trimethylpentene-2. These are actually the substances which exist in the mixture known as "diisobutylene," which was first made by Butlerow nearly seventy-five years ago.

The polymerization can proceed farther, either by the addition of the large positive groups to another molecule of isobutylene or by the addition of a positive butyl group to either of the two trimethylpentenes. The addition of the eight carbon positive fragment to the methylene group of another molecule of isobutylene, followed by the loss of a hydrogen ion, would give 2, 4, 4, 6, 6-pentamethylheptene-1 and the corresponding olefin with the double bond in the 2-position. These two olefins have recently been identified in this laboratory in the higher boiling fractions of "triisobutylene" formed by the polymerization of isobutylene or of tertiary butyl alcohol. If a tertiary butyl group added to the methylene group of 2, 4, 4-trimethylpentene-1 and a hydrogen ion was lost to give a double bond the products would be 2, 2, 4, 6, 6-pentamethylheptene-3 and unsymmetrical dineopentyl ethylene. These two substances have been identified in the lower boiling fractions of triisobutylene in this laboratory. Other workers have reported that "triisobutylene" contains substances which have two

tertiary butyl groups on the same carbon. To form these, a positive tertiary butyl group would have to add to 2, 4, 4-trimethylpentene-2. No product of this kind has been found to date in our studies, although we have carefully fractionated 150 gallons of crude triisobutylene through the very efficient semi-commercial columns of Dr. M. R. Fenske and his colleagues. Apparently a positive tertiary butyl group will not add to an olefinic carbon which already has a tertiary butyl group attached to it.

Extended studies are being conducted on more complicated cases of the polymerization of olefins. The present theory of the mechanism of this process is proving very useful in these experimental studies.

OBITUARY

HENRY STEPHENS WASHINGTON

AFTER a long illness, Henry Stephens Washington, one of the most eminent and picturesque personalities in American science, died at his home in Washington, D. C., on January 7, 1934.

Washington was born in Newark, New Jersey, on January 15, 1867, the son of George and Eleanor Stephens Washington. After receiving from Yale University the degree of A.B. in 1886 and A.M. in 1888, he continued postgraduate studies at Yale, Leipzig and the American School of Classical Studies at Athens.

Always intensely interested in many intellectual fields, he spent a number of the earlier years of his career in archeological excavations in Greece, and later was assistant for several years in physics and mineralogy at Yale. Though in his later life he did not participate actively in archeological research, he retained his love for the subject, and was a fellow of the Archeological Institute of America. Without being a specialist, he possessed a remarkable store of knowledge regarding ancient peoples, their origins and mode of life, and their monuments, inscriptions and art. He was widely read, had a very retentive memory, and there were few topics on which he was not able to converse with much more than superficial knowledge. His familiarity extended to such varied subjects as botany, philology, literature, the development of social customs and culinary art.

The scientific field to which he devoted the greater part of his life and in which he became recognized as an eminent authority was that of geology and mineralogy; chiefly, but not wholly, were his interests directed toward the aspects of these subjects to which his skill as an analytical chemist contributed. He and Dr. W. F. Hillebrand, working independently but toward the same end, recognized and insisted upon the value of exact determinations of rock constituents, at a period when many published analyses left much to be desired. Largely as a result of their labors the general standard of excellence of rock analyses has become, in later years, of a very different order than formerly. Washington's treatise, "The Chemical Analysis of Rocks," has passed through several editions and has been a standard text-book everywhere for nearly a generation. It embodies not only tested methods of analytical procedure but gives instructions regarding details of manipulation that are most important. As a further contribution toward the ideal he had in mind, a number of years ago he set himself the prodigious task of assembling from the literature all rock analyses that seemed worthy of attention, and calculated the results in terms of "normative minerals." From his familiarity with the subject he was able to group the analyses into superior and inferior and to point out in what respect the latter were defective. A second and enlarged edition of this monumental work, published by the U. S. Geological Survey in 1917, is a quarto volume of 1,201 pages. It is known to every geologist in the world. To those of Washington's acquaintances unfamiliar with the more earnest side of his character the amount of patient investigation and even drudgery to which he was willing to devote himself in this work is almost unbelievable.

This work further embodied a classification of igneous rocks by chemical composition according to a quantitative scheme devised by Washington in collaboration with Dr. Cross and Professors Iddings and Pirsson. Though this system now has rivals in somewhat similar schemes devised by others, it probably represents the first serious attempt at classification in this manner.

Petrological and volcanological investigations carried Washington on extensive travels in Greece, Asia Minor, Italy, Hawaii, Brazil and the United States, and many valuable publications resulted. He was gifted with exceptional linguistic aptitude and became proficient in the conversational use of a number of European languages, and even acquired a knowledge of Arabic.

From 1906 to 1912 he was engaged in professional work as a mining geologist. In 1912 he became a member of the staff of the Geophysical Laboratory of the Carnegie Institution of Washington. Here he remained until his death, except for a period during the war years, when he served as chemical associate and scientific attaché at the American Embassy in Rome. During his association with the Geophysical Laboratory he was enabled to pursue his investiga-

tions in the field and supplement them with laboratory studies, and prolific results followed. In the city of Washington the side of his nature that enjoyed the stimulus of personal contact and association with a multitude of friends found a congenial environment.

In addition to the subjects of investigation noted, mention should be made of his studies of volcanological phenomena, petrographic provinces, characteristic associations of elements in rocks, Hawaiian lavas, the occurrence of diamonds in Arkansas and Brazil, the composition of pyroxenes and amphiboles, fumarolic deposits, sources of potash, isostasy and the constitution of the earth as a whole.

He was happy in the recognition accorded his work by fellow workers at home and abroad, as indicated by official positions and honorary memberships to which he was elected. He was a member of the National Academy of Sciences; the Geological Society of America (vice-president, 1922); Mineralogical Society (president, 1924); American Philosophical Society; American Geophysical Union (chairman, 1926–1929); International Geophysical Union (vice-president, 1922); Washington Academy of Sciences; Cavalier, Order of the Crown, Italy; foreign correspondent, Geological Society of London; honorary member, Mineralogical Society (of England); Academie de France; foreign correspondent, Sociedad Española de Historia Natural; foreign member, Accademia dei Lincei; Societa Geologica Italiana; Modena Academy; Norway Academy and Turin Academy.

Washington took much delight in associating with congenial friends, and was one of the most active members of the Cosmos Club of Washington. In more public assemblages his features and bearing were of a character to make him an outstanding figure. His was a many-sided and exceptional personality, in many ways almost unique. His contributions to science are of lasting value.

C. N. F.

HOWARD CROSBY WARREN

THE news of Professor Warren's death on January 4 sent a wave of grief and shock through the older generations of contemporary American psychologists such as could have been caused by few other losses. Only eight days before, his friends had rejoiced to see him at the dinner in honor of Dr. Cattell, with his eyesight restored by an operation and his health and spirits apparently at their best.

His life was, in addition to its intellectual achievements, the triumph of an ideal temperament over the effects of disaster at the outset. Born on June 12, 1867, in Montclair, New Jersey, the son of a rich man, at eighteen months he was so burned by a lamp that during the first five years of childhood he suffered operation after operation, and he carried through life deep facial scars and a useless hand and eye. Yet in his autobiography he could say that his early life was "the story of a happy childhood, a pleasant home life and congenial playmates"; and write of his "uniform good-fortune after adolescence," when a more egocentric person would have gone with a heavily scarred temperament all his days.

Shortly after he was graduated from Princeton in 1889 he was appointed instructor in philosophy under President McCosh and Professor Ormond. In 1891 began a two years' sojourn at Leipzig, Berlin and Munich. He then became J. Mark Baldwin's assistant in the new Princeton laboratory. Three years later he was made assistant professor, and in 1902 succeeded Baldwin as professor of experimental psychology. He married Catharine Campbell in 1905. From 1914 to his death he was Stuart professor of psychology, although after 1920 he taught only in the first semester. He was president of the American Psychological Association in 1913.

A considerable part of his professional life was devoted to the interests of psychological journals. This career began in 1894, when he undertook with Livingston Farrand the compilation of *The Psychological Index*, an annual register of psychological literature in connection with *The Psychological Review*. In 1903–04 he became joint owner with Professor Baldwin of the *Review* journals, and added to them *The Psychological Bulletin*, with himself as editor: he bought Baldwin's interest in 1910. The American Psychological Association completed its purchase of the journals in 1928 when Professor Warren cancelled the last third of the price which the association had agreed to pay for them. The type of interest on his part indicated by these activities, that of creating intellectual tools for his science, reached its culmination in the task which with many collaborators he has left practically completed: the compilation of an exhaustive "Dictionary of Psychology and Cognate Sciences."

He had a mind of fine clarity and balance. These qualities appear in his books ("Human Psychology," 1919, enlarged edition 1920, revised edition with L. Carmichael, 1930; "A History of the Associational Psychology," 1921); they appear also in his opinions. He was a mechanist, rejecting the haziness of vitalism. He accepted as valuable both objective and introspective methods, including the configurational type of introspection.

Above all, he was a man of directness and vigor, a spirited opponent but never an enemy, and a friend who met his friends always with warm interest and good cheer.

MARGARET FLOY WASHBURN

HOMER COLLAR SKEELS

HOMER COLLAR SKEELS, botanist in the United States Department of Agriculture, Washington, D. C., died on January 3 at East St. Louis, Illinois.

In 1895 Mr. Skeels entered the Michigan Agricultural College, specializing in botany, and graduated in 1898 with the degree of bachelor of science. Mr. Skeels entered the Bureau of Plant Industry of the United States Department of Agriculture in November, 1907, and at the time of his death was a botanist in the Division of Foreign Plant Introduction of that bureau.

During the years spent in the service of the Department of Agriculture, Mr. Skeels built up what may be rightly considered the largest and most complete collection of economic foreign seeds in the United States, if not in the world. This now includes nearly 45,000 samples. As a result of his work, Mr. Skeels had acquired a nation-wide reputation as an expert in the identification of seeds.

He was a member of the Botanical Society of America, the Botanical Society of Washington, the Biological Society of Washington, the Washington Academy of Sciences and a fellow of the American Association for the Advancement of Science.

P. R.

SCIENTIFIC EVENTS

GIFTS TO THE BRITISH NATURAL HISTORY MUSEUM

ACCORDING to the London *Times* the trustees of the Rowland Ward Bequest have presented to the Natural History Museum, South Kensington, three mounted specimens: the head of a female Bighorn sheep from North America, a rare yellow-handed Titi monkey from Brazil and a black-headed Uakari monkey from the Amazons. A collection of mammals, mostly large ungulates, shot by Major P. H. G. Powell-Cotton in north East Africa, has been presented by him to the museum, among them a Sudani giant eland; with the skins are complete skeletons.

The late Mr. C. C. Lacaita, who presented to the museum during his lifetime his monocotyledons and Sikkim plants, has bequeathed to the department of botany the remainder of his collection, some 40,000 sheets, mainly from Italy and Spain, but also collected from Greece, Styria and France. The richness in critical Italian plants is the more appreciated since the museum herbarium was poor in Italian material. Mr. Lacaita's cabinets accompany the herbarium as the gift of his daughter, Mrs. Windsor Clive. Colonel A. H. Wolley Dod has presented his collection of British brambles, containing over 1,000 specimens, largely from Cheshire. Some 900 plants from the Cambridge Expedition to British Guiana have been received through Dr. G. C. Carter, the leader of the expedition, and T. G. Tutin, its botanist.

Among additions to the department of geology are a slab, 8 feet high, containing a reconstructed group of palm-leaves from the Tertiary beds of Italy (the gift of Lord Rothschild), and a small assemblage of British fossil vertebrates, including Eocene mammal and bird remains from the Isle of Wight and Liassic reptiles from Dorset and Yorkshire; these have been collected and presented by Mr. S. L. Wood. Gifts to the department of minerals include crystallized sprays of native gold from the City Deep Mine, Witwatersrand (from the Central Mining and Investment Corporation) and tektites, resembling the Australian "Black Men's Buttons," from Billiton, in the Dutch East Indies, presented by Engineer R. J. van Lier. A Chinese carving in fluorspar has been purchased as an example of the working of this material. A large series of rocks and minerals has been collected for the department by Mr. W. Campbell Smith in the United States and in Canada. Material was also selected by him from the duplicates of the U. S. National Museum and the U. S. Geological Survey.

THE GEOGRAPHIC PLAYERS, INC.

A GEOGRAPHIC theater has been organized in New York City by a group of geographers, explorers and scientific men. Members of the new theater have formed the Geographic Players, Inc., and will present programs combining motion pictures, lantern slides, lectures and native music and dancing.

The aims of the new theater, according to Dr. Roy Chapman Andrews, one of the organizers, as reported in *The New York Times*, are:

> To establish a legitimate theater with stage and screen where the world's geographers, explorers and scientists may present their experiences and records in a popular way.
>
> To foster through the spoken word and pictures appreciation for reality and natural beauty, which has been developed by scientific researchers who work with camera, microscope and telescope, whether under sea, on the earth or in the air.
>
> And to present this knowledge of the truth of life and the customs of the different peoples who live in the world, so that it may become of educational and inspirational value to the public.

The Geographic Players will present all their programs for the time being at the Waldorf-Astoria Hotel. Carveth Wells, the explorer, will be master of ceremonies.

The first program will be on China and will be given on Sunday, January 21, starting at 8:30 P. M. It will be directed by Princess der Ling, first lady-in-waiting to the late Empress Dowager of China. The Princess also will speak on her experiences at the Manchu Court.

Other participants will be Dr. Andrews, who will show motion pictures and lecture on his explorations in China; Lucille Douglass, archeologist, presenting painted slides of Far Eastern gardens, and Chester Su and Miss Han, who will give a program of Chinese music.

The people and life of Mexico will be the subject of the second program by the players, on Sunday night, February 4. Russell Hastings Millward, the explorer, is director of the program. He will also show motion pictures and lecture on the Mexican jungle and its products, present-day life and customs of the Mexican people and native dances and music.

Major James C. Sawders, explorer, will illustrate his lecture on the ancient civilization of the Mayas and Aztecs in Mexico with lantern slides. Motion pictures of Popocatepetl and the Floating and Borda Gardens of Mexico, to be shown by Julia Barrett Rublee, artist, and a series of songs and dances by native Mexicans, directed by Mrs. Mary Richards Bauer, well-known musical director, will be other features of this program.

The Italian program on Sunday night, February 18, will be supervised by Professor G. A. Borgese, Italian author and visiting professor at Smith College. He will speak on Italian literature. Maestro Sturani, of the Metropolitan Opera Company, will be heard in a program of Italian songs, and motion pictures will be presented of the most interesting places in Italy, featuring a travelogue of famous Italian gardens and villas.

Among members of the advisory board are: Dr. Mary T. Woolley, president of Mount Holyoke College; Dr. Wallace W. Atwood, president of Clark University; Dr. Charles B. Davenport, Dr. Ferdinand W. Haasis and Dr. Morris Steggerda, of the Carnegie Institution; Professor Mark A. May, of Yale University; Dr. L. A. Wolfanger, of Columbia University, and Dr. Erwin Raisz, of Harvard University, and Dr. Elmer D. Merrill, director of the New York Botanical Garden.

WILD-LIFE RESTORATION

PRELIMINARY investigations by the President's committee on wild-life restoration appointed by Secretary Wallace on January 2 to outline a course of action to aid in the restoration of game by utilizing for that purpose some of the marginal farm lands to be retired from unprofitable crop production, indicate that the additions to the public domain contemplated may serve important economic as well as game restoration purposes.

Reforestation, flood and erosion control, sustenance farms for the partial support of numbers of older employed residents who would practice game and forest management in the tracts, and use of Federal relief workers to execute projects requiring considerable labor, are contemplated. Sources of income from forest products and recreational privileges, with a view to development of self-supporting perpetual management, are being explored.

Coordination of Federal departmental functions in utilization of the areas to be acquired is envisaged by the committee in development of the lands to the point of greatest public usefulness. Cooperation of the Forest Service, Bureau of Reclamation, Soil Erosion Service, Bureau of Biological Survey and any divisions of the Federal Government identified with natural resources under Federal control is contemplated. Cooperation of the Special Senate Committee on Conservation of Wild-Life Resources and bureaus has already been enlisted.

The committee, composed of Thomas H. Beck, Wilton, Conn., chairman; J. N. Darling, Des Moines, Iowa, and Professor Aldo Leopold, Madison, Wis., has proceeded with early development of the game restoration plan following its first meeting on January 6. It is announced that all the projects to be evolved will probably be confined to pre-determined sections where the land retirement proposal will be effected, and to Federal lands already available.

In a letter, dated January 9, to all state game and conservation officials and interested organizations the committee states:

> The plan contemplates the restoration of migratory waterfowl and upland game. The need for such a program is apparent to every student of wild-life conservation and restoration in the United States, and it is obvious that the work should be confined to acquisition and restoration of suitable nesting areas for natural propagation purposes.
>
> This committee seeks information from all authorized sources, including government departments, state officials and leaders of interested organizations, and aims to coordinate, in one unified program, the best ideas of all interested parties.
>
> While there is a vast amount of information available in government bureaus and departments, we will be glad to receive information and suggestions with regard to suitable natural propagation areas which you may know of and which come under the classification of waste or sub-marginal land.

Stating that organizations should contact their nearest state game commissioner through whom localized projects may be recommended and brought to the committee's attention, the letter concludes:

If the plan is accepted and approved by the President and the Secretary of Agriculture, it will be financed out of federal funds.

AN AERIAL PHOTOGRAPHIC SURVEY

SECRETARY OF THE INTERIOR ICKES, acting on behalf of the Soil Erosion Service, awarded recently to the Fairchild Aerial Surveys, Inc., a contract for making the largest single aerial photographic mosaic map ever undertaken. This map will depict 24,500 square miles of the Navajo and Zuni Indian Reservations, of the three states of Arizona, New Mexico and Utah, an area which approximates the combined size of the five eastern states of Connecticut, Massachusetts, New Hampshire, Delaware and Rhode Island.

The map will be a mosaic assembled from more than 4,500 individual aerial photographs, and will be on a scale of one inch to 2,300 feet, with dimensions of approximately 40 feet by 24 feet. The photographs will be taken from an altitude of over 20,000 feet. The camera to be used is a specially designed four-lens topographic map machine, the four prints of which are transformed into a single picture. These pictures can be used in the Stereoplanigraph to produce actual contour maps of any part of the photographed area at a cost far below the cost of ground surveys. The map is needed in the work of erosion control, range rehabilitation and land-use planning now being carried out on the reservation by the Soil Erosion Service. The Indian Service and the Carnegie Institution are cooperating with the Soil Erosion Service in this undertaking.

At present there are no accurate maps of the greater part of the Navajo Reservation. Some portions of the reservation are actually unexplored. Accurate base maps are essential to intelligent planning in connection with the land-use readjustments and range improvements to be carried out. The total cost of the aerial survey will approximate $77,000, whereas the cost of a ground survey would exceed $500,000.

The conservation and rehabilitation work to be done on these Indian lands has been made necessary by the progressive impoverishment and destruction of the ranges by soil erosion following over-grazing. This depreciation of the land is proceeding so fast that very large areas will soon become practically uninhabitable unless remedial measures are immediately instituted and persistently pushed forward. Already numerous small areas and some of large extent have been essentially ruined, while most of the country where water is available for stock has been so severely used that it bears little resemblance to the original conditions.

THE RUDOLPH MATAS AWARD

THE medal of the recently created Matas Award in Vascular Surgery will be presented for the first time on January 23. The recipient of this award will be Dr. Mont R. Reid, professor of surgery at the University of Cincinnati.

The fund by which this award is made possible was created by Mr. Mike S. Hart in compliance with the expressed desire of his sister, the late Miss Violet Hart, to do something to honor Dr. Matas. Mr. Hart drew up a deed of gift establishing the Violet Hart Fund to be administered by Tulane University. "The fund is to provide an award, to be known as the Rudolph Matas Award, to be made to that North American surgeon who has contributed outstanding work in vascular surgery." This award is to be made as the occasion arises by a committee of surgeons selected for life by the Hart family with the addition of the surgeon occupying the chair of surgery in the Under-Graduate School of Medicine, Tulane University.

The committee as constituted at present is composed of Dr. Emile Bloch, *chairman,* Dr. Lucien Landry and Dr. Isidore Cohn, with Dr. Alton Ochsner, the present occupant of the chair of surgery. The first presentation will be unique in that the medalist will receive the award from the hands of Dr. Matas.

The correspondent who sends us the above information writes:

Dr. Rudolph Matas is a native Louisianian of Spanish parentage. By education, training and interest he is a citizen of the world. Dr. Matas graduated from Tulane University in 1880. In 1895 he was made professor of surgery in his *alma mater,* and in this capacity he served until his retirement in 1927. He has been director of the Department of Surgery at Touro Infirmary since 1905. For more than fifty years he has been a member of the Charity Hospital Staff.

Many institutions have conferred honorary degrees on Dr. Matas. Among these are Washington University of St. Louis, LL.D., 1915; the University of Pennsylvania, Sc.D., 1925; Tulane University, Sc.D., 1926; Princeton University, ScD., 1928. He has also received many decorations from foreign countries, the most recent of these was conferred by the Republic of Spain on December 3, 1933. Dr. Matas was awarded the Bigelow Medal by the Boston Surgical Society in 1926. This honor he has shared with W. J. Mayo, W. W. Keen, J. M. T. Finney and Chevalier Jackson.

Dr. Matas has contributed in such diverse fields and his knowledge of the literature is so great that his colleagues have felt for many years that by consulting him they could extract more information from his encyclopedic mind than they could obtain from a visit to a library.

Vascular surgery has been one of the many phases of surgery to which he has devoted his energy. His contributions in this field represent an epoch in the advancement of surgical knowledge. His contributions to local and regional anesthesia, surgical diseases peculiar

to the Negro, and his studies in fractures stand as classics.

Dr. Reid, the recipient of the first award to be made, is at present professor of surgery at the University of Cincinnati. For years he served as assistant to the late Dr. W. S. Halsted, professor of surgery in The Johns Hopkins University. During this association with Professor Halsted, Dr. Reid became an ardent admirer of Professor Matas and through the years his admiration and appreciation for Dr. Matas and Professor Halsted caused him to direct his efforts in the field of vascular surgery, in which he has won high distinction.

SCIENTIFIC NOTES AND NEWS

AT the Boston meeting of the American Physical Society Professor Arthur H. Compton, of the University of Chicago, was elected president and Professor R. W. Wood, of the Johns Hopkins University, was elected vice-president.

PROFESSOR A. B. COBLE, of the University of Illinois, has been elected president of the American Mathematical Society for the year 1934. The vice-presidents are Professor J. W. Alexander, of Princeton University, Professor Marston Morse, of Harvard University, and Professor H. S. Vandiver, of the University of Texas.

DR. GEORGE H. PARKER, professor of zoology at Harvard University, has been elected president of the Society of the Sigma Xi.

DR. CHAS. F. MARVIN, chief of the U. S. Weather Bureau, has retired, having reached the age of seventy-five years. Dr. Marvin will have served the bureau for fifty years next September and until then is expected to remain in an advisory capacity. He was appointed chief of the bureau in 1913, the President acting on the advice of the National Academy of Sciences before making a selection. Dr. Marvin is succeeded by Dr. W. R. Gregg, who has been in the service of the bureau since 1904. Since 1915 Dr. Gregg has occupied the position of principal meteorologist and since 1917 has been in special charge of aerological investigations.

DR. JOHN L. RICE, who has served for ten years as public health officer of New Haven, Connecticut, has been appointed by Mayor LaGuardia commissioner of health of New York City. Dr. Rice is chairman of the section for health officers of the American Public Health Association. Dr. S. S. Goldwater, advisory expert for many institutions in the United States and abroad, consultant on health and hospitals to the Board of Estimate in 1917 and formerly head of Mount Sinai Hospital, has been appointed commissioner on hospitals.

PROFESSOR P. A. DANGEARD, director of the laboratory of botany at the University of Paris, has been elected vice-president of the Paris Academy of Sciences. Election to the presidency will follow automatically in 1935.

M. R. THIRY, professor of mechanics in the University of Strasbourg, has been elected a correspondent of the Paris Academy of Sciences in the section for mechanics.

THE *British Medical Journal* reports that Dr. Alexander von Lichtenberg, professor of surgery at Berlin, has been made a foreign member of the Swedish Medical Society; Dr. Max Heinrich, Fischer professor of cerebral investigation at Berlin, a corresponding member of the Royal Medical Academy at Rome, and Dr. Erich Lexer, professor of surgery at Munich, a foreign member of the Lombardy Surgical Society.

THE gold medal of Villanova College for 1934 will be presented on January 28 to Abbé Georg LeMaître, of Belgium, visiting professor at the Catholic University, Washington. The medal is presented annually by the college to a Catholic who has performed distinguished service to science.

THE Legion of Honor of France has been awarded to Dr. James H. Kimball, meteorologist since 1895 at the New York Station of the U. S. Weather Bureau, "for the aid he, as one of the world's foremost aviation weather authorities, gave to the French aviators flying the Atlantic."

CAPTAIN ALBERT W. STEVENS, U. S. Army Air Corps, has been awarded the Franklin L. Burr prize of the National Geographic Society of the value of $1,000 in recognition of his work on aerial photography, particularly his photograph from 26,000 feet altitude of the moon's shadow during the total solar eclipse of 1932.

DR. JOSIAH F. REED was awarded the Seibert Memorial Prize of the Harrisburg Academy of Medicine at its annual banquet. The award, which is $500, to be used in visiting medical centers in Europe, was established in memory of the late Dr. William Seibert, Steelton, by his sister, the late Anna Mary Seibert. It is given every two years to a member of the academy who has done notable work. Dr. Reed is an obstetrician on the staff of the Harrisburg Hospital.

AT the thirty-first annual meeting of the American Society of Zoologists held at Cambridge from December 28 to 30, the following officers were elected: *President,* A. H. Sturtevant; *Vice-president,* H. W. Rand; *Secretary,* H. B. Goodrich; *Treasurer,* B. H. Willier; *Member of the Executive Committee,* Charles Zeleny.

THE newly elected officers of the Botanical Society of America are: *President,* E. D. Merrill, director of the New York Botanical Garden; *Vice-president,* H. L. Shantz, president of the University of Arizona. The treasurer, H. A. Gleason, New York Botanical Garden, and the secretary, were elected one year ago, for longer terms. Officers of the sections of the society, elected or announced at the same meeting, are: General Section—*Chairman,* William H. Eyster, Bucknell University, Lewisburg, Pa.; *Secretary,* Adriance S. Foster, University of Oklahoma. Physiological Section—*Chairman,* Charles F. Hottes, University of Illinois; *Secretary,* E. F. Hopkins, Cornell University. Systematic Section—*Chairman,* O. E. Jennings, Carnegie Museum, Pittsburgh; *Secretary,* Edward H. Graham, Carnegie Museum, Pittsburgh.

OFFICERS of the American Society of Plant Physiologists are: *President,* Dr. C. O. Appleman, University of Maryland; *Vice-president,* Dr. H. R. Kraybill, Purdue University; *Secretary,* Dr. A. E. Murneek, University of Missouri.

THE Genetics Society of America has elected as *President,* Sewall Wright, and as *Vice-president,* D. F. Jones. These, together with the *Secretary-Treasurer,* P. W. Whiting; the *Retiring President,* R. A. Emerson, and the *President for 1932,* L. C. Dunn, constitute the executive committee for the coming year.

THE newly elected officers of the Ecological Society are as follows: *President,* George D. Fuller, University of Chicago; *Vice-president,* Paul S. Welch, University of Michigan; *Secretary-Treasurer,* Arthur G. Vestal, University of Illinois. Newly elected members of the Editorial Board of *Ecology* for three years to succeed Needham, Nichols, Pearson and Powers are: Bertram Wells, F. C. Gates, W. P. Taylor and Francis Harper. The newly elected members of the Editorial Board of "Ecological Monographs" for three years to succeed Juday and Transeau are: Paul B. Sears and A. H. Wright.

J. FRANKLIN COLLINS, senior pathologist of the U. S. Department of Agriculture at Providence, R. I., has retired at the age of seventy years, after serving as forest pathologist for twenty-one years. Mr. Collins also has been lecturer in botany at Brown University.

DR. ROBERT DAVIS, head of the American Library in Paris, has resigned as superintendent of the American Hospital at Neuilly, which post he had accepted for a period of eighteen months. Dr. MacIlroy, director of the school of medicine at Richmond College, Virginia, will take his place.

WILLIAM A. SCHOENFELD, dean of agriculture and director of the agricultural experiment station at Oregon State College, has recently been appointed by W. I. Meyer, governor of the Farm Credit Administration, a member of the board of directors of the regional office of the Federal Farm Credit Administration at Spokane, Washington. This appointment will not interfere with his work at the college.

COLONEL SAMUEL PRICE WETHERILL, JR., president of the Philadelphia Art Alliance and member of the executive committee and former president of the Tri-State Regional Planning Federation, has been elected chairman of the Board of Trustees of the Philadelphia College of Pharmacy and Science at a meeting of the trustees on January 9. He has been a member of this board since 1921. He succeeds Joseph W. England, who had been chairman from 1924 until his death on December 2.

DWIGHT B. DEMERITT, professor of forestry at the University of Maine, was recently appointed to succeed the late Professor J. M. Briscoe as head of the department.

MR. F. R. KILLE has been appointed instructor in zoology at Swarthmore College. Dr. W. J. Scott has been granted a year's leave of absence and Robert K. Enders has been appointed acting chairman of the department of physiology and zoology.

UNIVERSITY readers have been appointed in the University of London as follows: Botany, Birkbeck College, Dr. F. C. Steward, Leeds; Epidemiology and vital statistics, London School of Hygiene and Tropical Medicine, Dr. A. B. Hill, University of London.

DR. HERBERT U. WILLIAMS, professor of pathology and bacteriology, University of Buffalo School of Medicine, is on leave of absence until March, to visit the Philippine Islands and the East Indies.

PROFESSOR H. K. HAYES, chief of the division of agronomy and plant genetics at University Farm, Minnesota, has accepted an invitation to deliver the Spragg Memorial lectures at Michigan State College, instituted in memory of a former head of the work in plant breeding at Michigan State College. Dr. Hayes will deliver five lectures over the period of the series.

DR. JEAN R. OLIVER, professor of pathology at Long Island College of Medicine, will deliver the tenth Ludvig Hektoen Lecture of the Frank Billings Foundation of the Institute of Medicine of Chicago on February 23. His subject will be "The Problem of Architectonics in Terminal Bright's Disease."

DR. HAROLD C. UREY, of Columbia University, delivered the second lecture under the Dohme lecture series for 1933–34 at the Johns Hopkins University on January 12 on "Some Differences in the Thermodynamic Properties of the Hydrogen Isotopes." Dr. Urey was formerly associate in chemistry at the Johns Hopkins University from 1924 to 1928.

DR. CHARLES F. CRAIG, director of the department of tropical medicine, Tulane University of Louisiana School of Medicine, New Orleans, will give the second Jessie Horton Koessler Lecture of the Institute of Medicine of Chicago on January 26. He will discuss amebic dysentery. Dr. Ludvig Hektoen is chairman of the board of governors of the institute.

DR. HERBERT GROVE DORSEY, principal electrical engineer of the U. S. Coast and Geodetic Survey, gave a lecture before the Washington Society of Engineers on January 3, on "Modern Hydrographic Surveying." The lecture included a demonstration of the fathometer for visual measurement of ocean depths and working models of ship and hydrophone station equipment used by the Coast Survey in Radio Acoustic Position Finding.

DR. ARTURO CASTIGLIONI, professor of the history of medicine in the University of Padua, recently gave the Nathan Lewis Hatfield Lecture of the College of Physicians of Philadelphia on "The Medical School at Padua and the Renaissance of Medicine."

PROFESSOR J. R. LEARMONTH, of the University of Aberdeen, gave in January a course of three lectures, illustrated by lantern slides, at St. Bartholomew's Hospital Medical College, London, on "The Surgery of the Nervous System, with Reference to the Use and the Elucidation of Physiological Phenomena."

A BEQUEST of $25,000 is made from the estate of the late Mrs. Mary Hyndman to establish the James Gilmour Hyndman Fellowship in preventive medicine at the University of Cincinnati. Dr. Hyndman was a member of the faculty of the college for several years before his death.

THE University of Arkansas has recently been granted by the Federal Public Works Administration a loan of $1,665,000, including a grant of 30 per cent. of the cost of labor and materials. Out of this fund $1,165,000 will be used to erect a library building and a chemistry building at the main university at Fayetteville and the remaining $500,000 will be used to construct a building for the Medical School at Little Rock. Plans and specifications for all three of the buildings are ready and it is expected that construction will begin within the next two months.

PRESIDENT JOHN LLOYD NEWCOMB, of the University of Virginia, has received official authorization of the appropriation of $379,000 toward the construction of new engineering buildings by the federal public works administration. The construction of the new engineering group will, Dr. Newcomb estimates, keep an average of 144 men busy for a year or more. When work is started about 100 men will be employed, and the number will increase until 150 are on the payroll of the project. The size of the buildings and the character of the equipment to be installed will make it impossible to open them for teaching purposes until September, 1935. But there will be little delay in starting construction, and bids are to be advertised for within 30 days.

A COMMITTEE for Survey of Research on the Gonococcus and Gonococcal Infections has been formed by the Division of Medical Sciences of the National Research Council, in cooperation with the American Social Hygiene Association. Its purpose is to collect, analyze and collate the facts already established and the efforts now in progress to add to knowledge of the gonococcus and gonococcal infections, especially as regards bacteriology, pathology, immunity, mechanism of infection and some of the forms of therapy. At the close of the preliminary survey, the committee, with the assistance of a conference of experts, will compile a report with the object of stimulating interest in the study of the gonococcus, of providing a point of departure and of suggesting promising leads for further investigation. Dr. Stanhope Bayne-Jones, *chairman,* invites the cooperation of workers interested in this field. Other members of the committee are Dr. Edward L. Keyes, Dr. Walter Clarke, *secretary,* and Dr. Francis Blake, chairman of the division, *ex-officio.* Headquarters have been established at Room 1101, 450 Seventh Avenue, New York, where communications and reprints will be welcomed.

UNDER the direction of Ray S. Owen, professor of topographic engineering at the University of Wisconsin, field work has been started by unemployed civil engineers and surveyors in Wisconsin for the purpose of extending the present network of triangulation belts and level lines of the geodetic control survey of the United States. The work is being done under an appropriation of $42,616 which has been allotted by the state civil works administration. Professor Owen is the Wisconsin representative of the U. S. Coast and Geodetic Survey, and has charge of all the field work in Wisconsin. Local CWA units throughout the state are cooperating in the establishment of concrete monuments for traverse stations. As rapidly as civil engineers and surveyors in each section are organized and traverse points established, they are being sent out into the state. At present there are more than 27 engineers working on the project. The Wisconsin quota is 320 men of a total number of 15,030 for the entire country. The work consists of developing a supplementary network to the existing first-order triangulation system by means of which miscellaneous points of prominence and importance will be located

and will serve as controls for future survey work performed by cities in the state. This will enable such surveys to be in accordance with the precise first-order system and make them of greater importance for future reference and record.

STEPS have been taken at the University of Leeds to secure a research fellow to investigate the cause and cure of chronic rheumatism and allied conditions, in order that he may enter on his duties early in 1934. This is the outcome of a deputation, headed by the Earl of Harewood, visiting the university and proposing a scheme of cooperation between the university and the Royal Bath Hospital, Harrogate. An advisory committee of the university has been set up to take general supervision of the work.

DISCUSSION

PALEOZOIC AGE OF THE ROCKS OF CENTRAL NEW HAMPSHIRE

ON the new geological map of the United States issued during the past summer by the U. S. Geological Survey, most of central New Hampshire is shown as "pre-Cambrian, some early Paleozoic rocks may be included." The representation of the geology of this state was based in large part upon a map which I submitted in January, 1932, to Mr. George W. Stose, editor of geological maps for the U. S. Geological Survey. Field work during the summers of 1932 and 1933 has shown that my assignment of the rocks of central New Hampshire to the pre-Cambrian is erroneous. Many of the schists are definitely metamorphosed Silurian and Devonian. Others are pre-Silurian, probably Ordovician but possibly older. Most of the intrusive rocks are younger than the Lower Devonian, but a few are Late Ordovician or older. It is very probable that there are no pre-Cambrian rocks in central New Hampshire, and perhaps in the whole state.

I assigned the rocks of central New Hampshire to the pre-Cambrian on the basis of field work in the North Conway quadrangle during the summers of 1925 and 1926 and the Littleton and Moosilauke quadrangles in 1931. There are no fossiliferous strata within thirty-five miles of the North Conway quadrangle, and the conclusion that many of the schists and orthogneisses are pre-Cambrian was based on long-range correlation. The writer stated that "the evidence as a whole is admittedly inconclusive, but it favors an early paleozoic or pre-Cambrian age of the Montalban schists."[1]

A pre-Cambrian age was also suggested by field work in the Littleton and Moosilauke quadrangles in 1931. The fossiliferous Silurian and Devonian are underlain by a great thickness of slates and volcanics, the metamorphism of which is low-grade. These rocks were believed to be Cambrian and Ordovician. To the southeast of the Silurian and Devonian and the supposed Cambrian and Ordovician are metamorphic rocks of intermediate grade and high grade. Because of their higher metamorphism and an apparent stratigraphic position beneath the supposed Cambrian and Ordovician, they were believed to be older than any of the other rocks and thus pre-Cambrian.

I fully realized, however, that the data were not conclusive and that more field work would be necessary before a definite decision could be reached. Unfortunately, my manuscript of the map had to be prepared in 1932 during this period of uncertainty. On the basis of the data available I assigned the rocks of central New Hampshire to the pre-Cambrian.

As field work progressed during the summer of 1932 and the stratigraphy and structure of the metamorphic rocks of intermediate grade were unraveled, it became clear that they were merely the more heavily metamorphosed equivalents of the Devonian, Silurian and older rocks. Moreover, it was established that most of the intrusive rocks, originally assigned to the pre-Cambrian, are actually younger than the lower Devonian. Finally, in the summer of 1933, with the extension of the field work, it became apparent that even the high-grade metamorphic rocks are Paleozoic.

The conclusion that most of the schists and igneous rocks of New Hampshire are Paleozoic is not a new idea. In the early part of the present century Hitchcock reached a similar conclusion[2] and in a sense the writer is merely substantiating a suggestion put forth thirty years ago.

Table I shows the stratigraphic units established during the past three summers in west-central New Hampshire between the Connecticut and Ammonoosuc Rivers. The age of the Fitch and Littleton formations is based upon paleontological data which will be presented in detail in a forthcoming paper by Arthur B. Cleaves and the writer. The Clough is either Lower or Middle Silurian. The age of the Albee, Ammonoosuc and Partridge formations is not known, other than pre-Silurian. Reconnaissance work strongly sug-

[1] Marland Billings, "The Petrology of the North Conway Quadrangle in the White Mountains of New Hampshire," *Proc. Am. Acad. Arts and Sci.*, Vol. 63, p. 79, 1928.

[2] C. H. Hitchcock, "New Studies in the Ammonoosuc District of New Hampshire," *Bull. Geol. Soc. Am.*, Vol. 15, pp. 461–482, 1904.

TABLE I

Lower Devonian	Littleton formation	Slate, sandstone and volcanics. 5,000 feet
Middle Silurian	Fitch formation	Calcareous shale, calcareous sandstone, arenaceous dolomite, arkose, quartz conglomerate. 700 feet
Lower (?) Silurian	Clough conglomerate	Quartz conglomerate and quartzite. 0–200 feet
	—— Unconformity ——	
Upper Ordovician (?)	Partridge slate	Black slate 0–2,000 feet
	Ammonoosuc volcanics	Chlorite and sericite schists of volcanic origin. 2,500 feet
	Albee quartzite	Quartzite and slate. 4,000 feet

gests that they are younger than the fossiliferous Middle Ordovician of eastern Vermont and therefore Upper Ordovician.

The paraschists between the Ammonoosuc and Pemigewasset Rivers, which in 1931 were believed to be pre-Cambrian, are now known to belong to these same six stratigraphic units, but in a higher stage of metamorphism. The slates and sandstones of the Littleton formation have become mica schists, garnet schists, staurolite schists, and, further to the southeast, sillimanite schists. The volcanics of the Littleton and Ammonoosuc formations, which are chlorite schists and sericite schists northwest of the Ammonoosuc River, are amphibolites and fine-grained biotite gneisses to the southeast. In the Fitch formation the calcareous shales have become biotite-calcite schists and the arenaceous dolomites now consist of actinolite, pyroxene, plagioclase and quartz. Similar changes occur in the other formations, except the Clough conglomerate, which is merely more coarsely crystalline.

Our mapping of the Moosilauke quadrangle demonstrates that the mica schists, garnet schists and sillimanite schists of Mt. Moosilauke are metamorphosed Devonian rocks. Reconnaissance work indicates that the sillimanite schists of the Presidental Range and elsewhere are likewise metamorphosed Devonian. It is very probable that most of the metamorphosed sedimentary rocks between the Pemigewasset River and the Maine border are Silurian and Devonian.

Four major periods of intrusive igneous activity have been recognized in central New Hampshire—the Highlandcroft, Oliverian, New Hampshire and White Mountain petrogenic cycles. The rocks of the Highlandcroft cycle include diorite, quartz diorite, granodiorite and granite. They are younger than the Partridge slate, but older than the Clough conglomerate. They are thus definitely pre-Silurian, and if the tentative assignment of the Partridge slate to the Upper Ordovician is correct, the Highlandcroft petrogenic cycle is Late Ordovician. The Oliverian rocks consist largely of biotite granite and are younger than the Lower Devonian but older than the major period of orogeny. The rocks of the New Hampshire magma series consist of diorite, quartz diorite, granodiorite, trondhjemite and granite. They are younger than the Lower Devonian and essentially contemporaneous with the great period of folding. Youngest of all are the rocks of the White Mountain ("alkaline") magma series, which are younger than the Lower Devonian and also later than the period of orogeny.

Thus three of the igneous series are younger than the Lower Devonian. To these three groups belong 90 per cent. of the igneous rocks of central New Hampshire. The other 10 per cent., the Highlandcroft group, is pre-Silurian and probably Late Ordovician, although the possibility of a greater age can not be definitely eliminated on the basis of the present data. On the recent geologic map of the United States only the rocks of the White Mountain magma series are shown as Paleozoic. All others were included under the symbol for the pre-Cambrian. In other words, Paleozoic intrusives are much more abundant than the map shows.

It is quite impossible to prepare a satisfactory geologic map of New Hampshire at the present time. No complete survey of the state has been made since the Hitchcock survey in the seventies. Although an excellent piece of work for its time, it can not be used as an adequate basis for a modern map. Fortunately the state is now completely mapped topographically and the geologic mapping of five quadrangles is now well advanced, and publication of the memoirs now in preparation should give definition to our present picture of Paleozoic history in this area.

MARLAND BILLINGS

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GLOSSARY OF TERMS USED IN DESCRIBING WOODS

THE December issue of *Tropical Woods,* published by the Yale School of Forestry, New Haven, Conn., contains a report by the Committee on Nomenclature of the International Association of Wood Anatomists on the standardization of terms used in describing woods. It is in the form of a glossary in which 126 terms are enumerated and succinctly defined.

The members of the committee are Professor Arthur J. Eames, Cornell University; Professors Irving W. Bailey, Ralph H. Wetmore and Robert H.

Woodworth, Harvard University; Professors George A. Garratt and Samuel J. Record (chairman, and secretary of the association), Yale University. About 20 other members of the association assisted in the work, which had its beginning at a conference of wood anatomists at Cambridge, England, in August, 1930.

With the backing of the association, the committee did not hesitate to make old terms more specific or to discard and replace names that were considered inappropriate or misleading. Thus *bars* and *rims of Sanio* are replaced by *crassulae; pits with cribiform membranes,* by *vestured pits; interxylary* and *intraxylary phloem,* by *included* and *internal phloem,* respectively; *conjugate cell* by *disjunctive cell; intermediate* or *substitute wood fiber,* by *fusiform wood parenchyma cell.* Among the various new terms are *pit-pair, pit annulus, blind pit, vasicentric tracheids, perforation plate* and *tylosoid.* There are precise definitions of *middle lamella, primary* and *secondary cell walls* (the committee does not recognize a *tertiary* wall), and of the different types of parenchyma and of pore arrangements. More than 100 of the terms have already been adopted as standard for the International Association of Wood Anatomists.

The report has been reprinted as a pamphlet of 12 pages, including notes and explanations, and may be obtained from the Yale School of Forestry for 10 cents apiece for single copies, with special discounts if ordered in quantities of 10 or more. Eleven hundred copies have already been sold.

SAMUEL J. RECORD

AUTOGAMY IN PARAMECIUM AURELIA

THE first intimation of orderly, deep-seated reorganization processes in *Paramecium aurelia,* apart from conjugation, was given by Woodruff and Erdmann.[1] Since that time, numerous researches have shown the wide-spread occurrence of rather profound internal readjustments, without cell fusion, in other species of ciliated protozoa.

This preliminary note records the occurrence of autogamy in the life history of several different races of *Paramecium aurelia.* Autogamy, as it has been worked out during the past three years—both from mass cultures and from animals bred in daily isolation cultures—is the counterpart, in a single individual, of the complex nuclear changes which are effected during conjugation. In the latter process two animals come together, and, following three maturation divisions of the micronuclei, gamete nuclei are formed. Two of these fuse to form a synkaryon which gives rise to a new nuclear apparatus. The old macronucleus, which has degenerated, is thus replaced by a new one of micronuclear origin.

In autogamy, the same type of reorganization as conjugation is effected by a single animal. At the time of the first micronuclear division in autogamy, the two small micronuclei increase tremendously in size, develop an elongated, thin, crescent-like form and later transform into large metaphase spindles. Two other divisions follow, whereby the gamete nuclei are formed. Since these three divisions are the exact duplicates, as far as can be determined, of those formed in conjugation, they are interpreted as meiotic divisions. Two of the gamete nuclei of the single animal undergoing autogamy fuse to form a synkaryon. This divides twice to produce four nuclei. Two of them become macronuclear anlagen while the other two remain small and undifferentiated, the two functional micronuclei. The macronuclear anlagen are distributed to two daughter cells at the time of the first cell division, at which time the micronuclei divide. The old macronucleus disintegrates, at about the time of the formation of the gametic nuclei, by elaborating a skein of chromatin-ribbons. This skein later divides transversely into a large number of sausage-shaped fragments which round up and are eventually resorbed into the cytoplasm. In autogamy, then, a new nuclear apparatus is reconstituted from the activity of a synkaryon produced by the gamete nuclei of a single individual.

Preliminary observations on *Paramecium caudatum* and *P. multimicronucleata* suggest the occurrence of autogamy in these species also.

Since autogamy involves maturation and fertilization and hence may be regarded as a sexual process, its genetic consequences—the introduction of heritable variation into the species—would be expected to be of the same order as those of conjugation.

In addition to this sexual process of autogamy, bringing about a drastic cellular reorganization, evidence has been accumulating as to the existence of a purely asexual reorganization process in *P. aurelia,* in which the macronucleus alone is involved. Further details of both processes will be published shortly.

WILLIAM F. DILLER

DARTMOUTH COLLEGE

CATARACT AS A RESULT OF DIETARY DEFICIENCY IN LARVAL AMBLYSTOMA TIGRINUM

IN larvae of the tiger salamander being reared on a series of highly purified milk-powder-casein diets, the lenses of the eyes turned milky-white in mid-larval life and passed through stages like those of "senile" cataract of the cortical type. At the stage

[1] L. L. Woodruff and Rh. Erdmann, "Complete Nuclear Reorganization without Cell Fusion in Paramecium," *Jour. Exp. Zool.,* 17, 425–518, 1914.

of swelling there appeared a total opacity of the lens cortex with degeneration of the cortical fibers, but the lens nucleus retained its crystalline transparency. It was clear that inadequacy of the basic milk diet had produced the disease, because it was lacking in other larvae from the same egg-masses fed on a series of synthetic beef muscle diets. Ten animals from the milk-fed groups had visible cataracts when changes were made in the rations. Increase of vitamin A or of vitamin G was ineffective in preventing development of the disease; nine new cases of the eye defect appeared. In another group of larvae fed on one of the milk-powder-casein diets, one case of cataract was developing when dietary addition was given. With purified cystine as food supplement and no change in the vitamin supply, the other members of this group remained free from the eye opacity.

ESTHER M. PATCH
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THE NORTHWEST CONIFEROUS CLIMAX

IN a recent note[1] the assumption is made that the coniferous climax of the Pacific Northwest can be attributed to the winter activity and hence the longer growing season enjoyed by the coniferous evergreens. The writer has no quarrel with the possible importance of length of growing season and consequent total growth as a factor in determining the climax forest (though Hemenway's evidence must be made quantitative as well as anatomical before the relative influence of winter activity on rate of growth can be properly evaluated), but does wish to protest the total disregard in the above note of other important ecological and physiological factors. Differences in longevity, seed production, resistance to injury and disease, and ability to germinate and survive under heavy shade and severe competition are some of the factors that must be considered along with rate of growth in any sound explanation of the resultant climax.

In the opinion of the writer, Hemenway is not justified, without due consideration of such factors, in assuming that the coniferous climax in the Northwest can be explained predominantly upon winter activity in the evergreen conifers.

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[1] Hemenway, SCIENCE, 78: 437.

REPORTS

APPROPRIATIONS FOR GRANTS-IN-AID BY THE NATIONAL RESEARCH COUNCIL

THE Committee on Grants-in-Aid of the National Research Council at its December meeting, out of 119 requests, made thirty-six grants for the support of research projects, as follows:

PHYSICAL SCIENCES

Mildred Allen, associate professor of physics, Mount Holyoke College, "the effect of tension on the electrical resistance of single crystals"; Richard A. Beth, assistant professor of physics, Worcester Polytechnic Institute, "detection of photon spin, in accordance with the quantum theory of light, by direct mechanical means"; John H. Clouse, professor of physics, University of Miami, "x-ray crystal structure"; J. M. Cork, associate professor of physics, University of Michigan, "nuclear disintegration under high potential"; Curtis R. Haupt, assistant professor of physics, Pomona College, "ionization of mercury vapor by electron impact"; Otto Struve, director of the Yerkes Observatory, and C. T. Elvey, assistant professor of astrophysics, Yerkes Observatory, "measurement of accurate contours of the absorption lines in B and A type stars"; Benjamin A. Wooten, professor of physics, University of Alabama, "energy distribution in certain nebulae and stars having continuous spectra."

ENGINEERING

H. Diederichs, director of the Sibley School of Mechanical Engineering, Cornell University, "heat transmission coefficients for steam in condenser tubes."

CHEMISTRY

John G. Aston, assistant professor of chemistry, Pennsylvania State College, "the heat capacities of simple organic compounds"; Simon Freed, instructor in chemistry, University of Chicago, "magnetic optic problems of crystals"; W. D. Harkins, professor of chemistry, University of Chicago, "the force constant for atoms of ordinary and heavy hydrogen in compounds"; W. George Parks, assistant professor of chemistry, Rhode Island State College, "the e.m.f. method for determining heats of dilution"; Milton J. Polissar, assistant professor of physics and chemistry, Armstrong College, "studies of chemical kinetics"; L. H. Reyerson, professor of chemistry, University of Minnesota, "preparation of gases of the methane series with the heavy isotope of hydrogen."

GEOLOGY AND GEOGRAPHY

George H. Anderson, research fellow in geology, California Institute of Technology, "alternations and replacements occurring in a granite batholith in the Inyo-White Mountain Range of California-Nevada"; Elmer H. Johnson, industrial geographer, Bureau of Business Research, University of Texas, "physical and economic characteristics of natural areas of the southwest Gulf region"; Christina Lochman, Chicago, Illinois, "the fauna of the Upper Cambrian Cap Mountain formation of Texas"; Edwin T. McKnight, associate geologist, U. S. Geological Survey, "igneous complex at Prospect

Mountain, near Litchfield, Connecticut''; W. A. Tarr, professor of geology, University of Missouri, ''chemical and bacteriological studies of the lead deposits of southeastern Missouri.''

MEDICAL SCIENCES

G. Howard Bailey, associate professor of immunology, School of Hygiene and Public Health, The Johns Hopkins University, ''heterophile antigens of bacteria and plant and animal tissues''; Raymond L. Garner, assistant in medicine, School of Medicine, The Johns Hopkins University, ''enzymatic liquefaction of clotted human blood''; R. W. Gerard, associate professor of physiology, University of Chicago, ''the activity of nerve tissue and the central nervous system''; Balduin Lucké, professor of pathology, School of Medicine, University of Pennsylvania, ''a neoplastic disease of the common leopard frog, *Rana pipiens*''; John R. Paul, assistant professor of medicine, and James D. Trask, associate professor of pediatrics, School of Medicine, Yale University, ''comparison of different strains of poliomyelitis virus''; Arthur H. Smith, associate professor of physiological chemistry, School of Medicine, Yale University, ''the influence of various 'inorganic' ions upon the body weight and blood changes of experimental animals.''

BIOLOGICAL SCIENCES

Ernest Anderson, professor of chemistry, University of Arizona, ''the composition of the polyuronides occurring in the wood of the Black Locust, *Robinia Pseudo-acacia*''; Edward D. Crabb, associate professor of biology, University of Colorado, ''comparative spermatogenesis in four species of viviparous snails''; Arthur T. Henrici, professor of bacteriology, University of Minnesota, ''ecologic survey of bacteria in a fresh-water lake (Lake Alexander, Minnesota)''; R. R. Huestis, professor of zoology, University of Oregon, ''inheritance of color character in *Peromyscus*''; Joseph C. Ireland, professor of plant breeding, Oklahoma Agricultural and Mechanical College, ''chloroplast development in virescent kafir seedlings''; Charles P. Smith, teacher of botany and economic biology, Senior High School, San Jose, California, ''study of the lupines of the Lindley Herbarium at Cambridge, England''; Harold B. Tukey, chief in research in pomology, New York State Agricultural Experiment Station, Geneva, New York, ''artificial cultures of embryos of decidous fruits.''

ANTHROPOLOGY AND PSYCHOLOGY

Peter H. Buck, 1933–34 Bishop Museum traveling professor of anthropology, Yale University, ''the material culture of the Cook Society and Austral Island groups in the South Pacific''; Frank A. Geldard, associate professor of psychology, University of Virginia, ''the limits of palmesthetic sensibility of various skin areas''; Melville Jacobs, instructor in anthropology, University of Washington, ''the recording of Indian languages and songs in the Northwest''; Morris E. Opler, research assistant in anthropology, University of Chicago, ''the cultural relationships of Apache tribes.''

The National Research Council will be ready to consider further requests for research assistance this spring. Applications should be filed with the Committee on Grants-in-Aid before March 15, 1934. Action upon these applications will be taken about the middle of May.

ISAIAH BOWMAN,
Chairman

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A NEW CULTURE MEDIUM FOR CLADOCERANS

IN recent investigations in this laboratory it has been necessary to use numbers of cladocerans. In order to raise these animals in quantities and under controlled conditions various culture media for cladocerans have been reviewed and tested. Most of the existing media call for manure to supply the organic matter, but as manure is such a variable the substitution of materials of more constant composition was tried. Wiebe[1] has pointed out that soybean meal is superior to manure for plankton production in pond fertilization, and more recently the U. S. Bureau of Fisheries has found cotton-seed meal quite, if not more, desirable for this purpose. It seemed logical, therefore, to substitute cotton-seed meal for manure in cladoceran culture media. This was done and a very satisfactory culture medium has been produced, having several advantages over the manure infusions as suggested by Banta.[2]

Pond water was filtered through coarse filter paper and added to a mixture of fine garden soil and cotton-seed meal (commercial cotton-seed meal, as used in dairy feeds), in the proportions of 1 liter of filtered water to 90 grams of garden soil and 17 grams of cotton-seed meal. After a thorough stirring, the mixture was set aside at room temperature in large Erlenmeyer flasks for five days. During this period the mixture fermented and produced considerable gas. At the end of five days the supernatant liquid was decanted off and strained through muslin. Analyses made by the Bacteriology Department of the University of Missouri showed that the strained fluid contained an almost pure culture of *B. coli*. The strained fluid was diluted with filtered pond water before using and re-strained through muslin whenever bacterial masses developed. The pH of the final diluted product was adjusted to 7.2 by the addition of sodium carbonate.

In strong concentrations of this medium bacterial

[1] A. H. Wiebe, *Bull. U. S. Bur. Fisheries*, 46: 137, 1930.

[2] A. M. Banta, SCIENCE, 53: 557, 1921.

masses formed which interfered with the free movement of the daphnia and often resulted in their death, but by a dilution of 1 part of the strained fluid as decanted from the original mixture with 100 parts of filtered pond water a medium was obtained which remained quite clear and in which daphnia grew rapidly and produced normal clones. It has been found desirable to renew the media in which the cultures of animals are growing from time to time, *i.e.*, at periods of a week or more, but the addition of more bacteria to the cotton-seed-meal medium, as suggested for manure infusions by Stuart and Banta,[3] has not been found necessary. Fresh stock supplies of the cotton seed mixture have been prepared each week, a small amount of an old mixture being added each time to insure inoculation with the original bacteria.

WALTER A. CHIPMAN, JR.
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UNIVERSITY OF MISSOURI

A CULTURE METHOD FOR DAPHNIA

SOME months ago, Professor E. G. Martin, of Stanford University, was kind enough to inform me that he had had considerable success in raising the phyllopod *Artemia* on commercial dried yeast which was dropped into the aquarium in small quantities from time to time. Ordinary Fleischmann's yeast (in cakes) being more readily obtained by me, I tried it on *Artemia* with excellent results.

The same yeast has been fed, for some two months, to a mass culture of *Daphnia magna* with striking results, reproduction and growth being markedly more rapid, and population more dense than with any of the usual media.

About one quarter of a fresh yeast cake is mixed into a uniform suspension with from 50 to 100 cc of water, and poured into the aquarium, which contains from 60 to 70 liters of water. The feeding is repeated every fifth or sixth day. It is necessary to have a stream of air bubbling through the medium at all times, or the yeast may prove lethal, probably by giving off CO_2.

The method has not been tried on other species of cladocera, nor has it been tried with few animals in small containers, but it is so successful in the mass culture, that it seems wise to make the food material known. It should be particularly useful in physiological work, in which the usual manure-infusion may be a source of large quantities of unknown solutes. It should also be valuable in raising *Daphnia* in large numbers as food for other organisms.

R. M. BOND
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[3] C. A. Stuart and A. M. Banta, *Physiol. Zool.*, 4: 72, 1931.

A SCHEME FOR DILUTIONS IN THE LABORATORY

FOR many years the writer has been using a simple and convenient scheme for calculating the amounts of solution and solvent to be used in making up a series of solutions of various concentrations from one or more stock solutions. This scheme has the merits of accuracy and adaptability to any situation, even to the mixing of two solutions to obtain one of intermediate concentration, provided the concentrations are given in terms of molar or normal solutions. In view of the space which many authors give to the problem of preparing solutions of correct concentration, it would appear that many research workers could save time and effort through knowledge of a reliable method of dilution.

The scheme can best be described and remembered by the following chart:

conc. of stock sol.		desired conc.—conc. of diluting agent = parts by vol. of stock sol.
	desired conc. of solution	
conc. of diluting agent		conc. of stock sol.—desired conc. = parts by vol. of diluting agent

In practise the three items at the left are written down in their correct positions and the concentration of the diluting agent is usually zero, because water (or other pure solvent) is commonly used. The other two items are calculated by subtraction, which, of course, involves only one operation when pure solvent is used, because the upper right-hand item is identical with the center one when the lower left-hand item is zero.

The following example will show how easily the desired results are obtained. If the stock solution is .450 M, the desired concentration is .125 M and the diluting agent is water, the completed procedure becomes

.450		.125
	.125	
0		.325

This indicates the use of stock solution and water in the ratios of .125 to .325 parts by volume. The exact amounts to be used can be 12.5 to 32.5, 5 to 13, 3.75 to 9.75 or any other combination obtained by multiplying both right-hand items of the chart by the same number.

This same scheme could be stated as a formula, but it is actually easier to use and to remember in the form just given. Students of different capacities seem to use it with almost equal facility, and the accuracy varies only with the care used in measuring the parts by volume.

CHARLES J. LYON
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SPECIAL ARTICLES

THE NATURE OF LYSOZYME ACTION[1]

THE lytic action on certain bacteria of a supposed enzyme, lysozyme, present in tears, egg white and various body tissues and fluids, has been described and studied by Fleming and others.[2] We have tried to determine whether the action of lysozyme is physical or enzymatic. A polypeptide in the form of an amorphous white powder, obtained by the purification of egg white, completely dissolved a suspension of air sarcinae (barium sulfate standard No. 8) in a concentration of 0.12 gamma per cc. An aqueous solution of the purified lysozyme did not change the surface tension of water and had no proteolytic, lipolytic or amylolytic action. It did not activate the action of papain or of the endoproteases of the bacteria. It did not act on lecithin or on the alcohol-ether soluble fraction of the sensitive sarcinae; it gave no evidence of a phosphatase action. It did split off a reducing sugar from ovomucoid and from a polysaccharide obtained by hydrolysis of the test organisms. The corresponding mucoid of the bacteria has not yet been isolated. The defatted bacteria are extremely insoluble, apparently consisting chiefly of a mucoid yielding a large carbohydrate fraction. Cartilage and chitin were not attacked.

Apparently lysozyme is an enzyme or an enzyme mixture which splits a reducing sugar from certain mucoids and from the polysaccharides derived from them. Its occurrence in tears, nasal, bronchial and gastro-intestinal mucus, egg white and semen[3, 4] can thus be understood, the bacteriolytic action being incidental. The same enzyme was obtained from a polypeptide fraction of the sensitive bacteria. The possible relation of this factor to bacteriophage action is being investigated. It is possible that this ferment may furnish an important tool for the study of mucins. It is to be expected that a series of such mucinases[5, 6] will be found in various tissues and organisms. A commercial pepsin preparation was found to split gastric mucin independently of peptic activity. It is possible that the specific bacterial polysaccharides are derived from capsular mucoids and that the enzyme described by Dubos and Avery[7] which decomposes the capsule of Pneumococcus III and hydrolyses its specific polysaccharide belongs to this group of ferments.

KARL MEYER
RICHARD THOMPSON
JOHN W. PALMER
DEVORAH KHORAZO

[1] From the Biochemical and Bacteriological Laboratories of the Department of Ophthalmology, College of Physicians and Surgeons, Columbia University, New York City.

[2] A. Fleming, *Proc. Roy. Soc. Med.*, 71: 26, 1932. Review.

[3] Kurzrok and Miller have shown that semen dissolves the mucous plug of the cervical canal.

[4] R. Kurzrok and G. Miller, *Am. Jour. Obstet. and Gynec.*, 56: 15, 1928.

[5] The term "mucinase" has already been applied to a ferment which coagulates mucin. The existence of such a ferment is not, however, well established.

[6] Oppenheimer-Kuhn, "Die Fermente und ihre Wirkungen," Vol. 2, Leipzig, 1925.

EFFECTS OF FEEDING SODIUM BICARBONATE OR LACTIC ACID UPON THE SEX RATIO IN RATS

SEVERAL articles have appeared recently in the newspapers to the effect that the ingestion of sodium bicarbonate during pregnancy influences the sex of the offspring both in the human and in the dog, males being produced exclusively. While there appears to be no physiological basis for such a belief, the necessity of increasing our rat colony gave an opportunity to test the question experimentally.

Animals to be bred were placed upon our stock diet, which consists of a mixture of ground grains, dried milk, mineral salts and cod liver oil, with which was incorporated either sodium bicarbonate or lactic acid. Following breeding, the animals were continued upon the same diet until parturition. The food seemed perfectly palatable, 15 to 20 grams being consumed per day.

The results are given in the following table:

Material and concentration	No. of litters	Males	Females	Total
2½ per cent. sodium bicarbonate	15	61	67	128
5 " " " "	20	85	101	186
2½ " " lactic acid	10	38	42	80
5 " " " "	28	107	128	235
Totals	73	291	388	629

Sex ratio, sodium bicarbonate animals, $\frac{\text{Females}}{\text{Males}} = \frac{168}{146} = 1.15$

Sex ratio, lactic acid animals, $\frac{\text{Females}}{\text{Males}} = \frac{170}{145} = 1.17$

In a group of 14 control litters the sex ratio of females to males was 1.03. Donaldson[1] quotes a table from King which includes data covering some 815 litters, showing a variation in female to male sex ratio of from 1.06 to .66.

[7] R. Dubos and O. T. Avery, *Jour. Exp. Med.*, 54: 51, 73, 1931.

[1] "The Rat," page 25, table 6.

In view of this variation, and of the close agreement between the sex ratios of the two groups in our study, we conclude that, for the rat at least, the sex ratio is not affected by the feeding of base or acid.

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THE EFFECTS OF THALLIUM SULFATE UPON SOILS

QUESTION has lately been raised concerning the ultimate effects, upon the soil, of the thallium compounds used for rodent control. S. C. Brooks[1] has warned land owners of the possibility that the soil might be sterilized by this practise. Obviously, such a problem merits investigation. The writer has developed critical methods during studies on weed control and is preparing a detailed report on tests with thallous sulfate. Meanwhile, he presents the following summary of pertinent results.

Using four California soils, the writer studied the initial toxicity, the decrease of toxicity with time and cropping, the saturation capacity of the soils and the effects of thallium-coated grain upon adjacent plants. Oat seedlings used as indicator plants were harvested 30 days after planting in the greenhouse tests.

In equimolecular concentrations, thallous sulfate proved many times as toxic as arsenic trioxide and sodium chlorate. Whereas toxicity of the latter soil sterilants decreased with successive cropping, that of thallous sulfate remained unchanged through three such treatments.

Thallium toxicity was tested through a range of 25 ppm to 2,000 ppm in the soil solution. It proved greatest in soils of low fertility but could not be correlated with soil type or water-holding capacity. The chemical was strongly fixed in all soils, the saturation capacity of Yolo clay being about 10,000 ppm on a dry weight basis. Leaching with 200 cm of distilled water had practically no effect on the location or toxicity of thallous sulfate in the soil.

Thallous sulfate is an extremely effective soil sterilant, it is strongly fixed and it resists leaching. Although these facts explain Brooks' observations and would seem to justify his warning, their aspect is changed by quantitative studies. Thallium-treated "potted" (hulled) barley had practically no effect upon germination or growth of oats planted in the same soil and spaced within ½ centimeter of the barley grains. When the spacing was decreased to ¼ centimeter, growth was reduced. Except where the dosage was excessive, oat seedlings were unaffected by the application of treated barley to the soil, followed by irrigation.

[1] S. C. Brooks, "Thallium Poisoning and Soil Fertility," SCIENCE, 75: 105–106, 1932.

Thallium-treated grain also affected vegetation in a pasture area very little. The heaviest application, equivalent to 27 pounds of thallous sulfate per acre, reduced growth less than 50 per cent.

In concentrations of 100 ppm or more (on a dry weight basis) thallous sulfate should, apparently, be fully toxic in most soils. At this rate, about 30 pounds would be required to sterilize an acre inch.

Calculations on the area sterilized by the grains comprising a squirrel bait (approximately 20 grams of poisoned grain) show that over 100,000 baits would be required to cover an acre. This is equivalent to 5,000 pounds of poisoned grain bearing 50 pounds of thallous sulfate and might sterilize the top 1½ inches of soil. Under natural conditions, however, the chemical would be fixed in a much shallower layer. The baits, if taken, would be distributed through the top four feet of soil and would have little sterilizing effect.

The disparity between these figures and the amounts used in field practise is striking. As shown by a brief survey of ground-squirrel control in California, the average initial dosage of poisoned grain bearing one per cent. Tl_2SO_4 is about 1/3 pound per acre; later applications are lighter. In one county the dosage has decreased to 1/35 of a pound in five years. The success of this material should permit similar reductions in other regions, so that the amount of chemical becomes totally insignificant as far as soil sterilization is concerned.

The writer observed no loss of fertility in range lands successfully treated for five successive years. The only denuded areas found were the open burrows, fresh mounds and beaten trails of squirrels in untreated fields. Regardless of other objections to thallium compounds in rodent control, the possibility of losing agriculturally valuable land through sterilization seems remote.

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BOOKS RECEIVED

ATKINS, WILLARD E. and ARTHUR WUBNIG. *Our Economic World.* Pp. ix + 411. Illustrated. Harpers. $1.68.

BULLER, A. H. REGINALD. *Researches on Fungi. Volume V.* Pp. xiii + 416. 174 figures. Longmans, Green. $10.00.

BURT, CYRIL and others. *How the Mind Works.* Pp. 336. Appleton-Century.

CONKWRIGHT, NELSON B. *Differential Equations.* Pp. xii + 234. Macmillan. $1.90.

Catalogue of the Works of Linnaeus, Preserved in the British Museum. Pp. xi + 246 + 65. 7 plates. British Museum.

DAVIS, HAROLD T. *Tables of the Higher Mathematical Functions.* Vol. 1. Pp. xiii + 377. Principia Press. $10.00.